

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A method performed by a computer for filtering interference and noise of an asynchronous wireless signal comprising the steps of:
 - receiving an asynchronous data vector including a spreading code;
 - using the received asynchronous data vector, ~~updating~~ to update weight coefficients of an adaptive filter without prior knowledge of synchronization ~~of synchronization~~ of the spreading code;
 - using the updated weight coefficients information to determine synchronization of the spreading code; and
 - demodulating the output of the filter using the determined synchronization of the spreading code for obtaining a filtered data vector.
2. (Currently Amended) The method of claim 1, further comprising the step of dividing the received asynchronous data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation \mathbf{T}_1 on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1 , and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.
3. (Currently Amended) The method of claim 2, wherein the transformation \mathbf{T}_1 is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^\dagger \\ \mathbf{B}_1 \end{bmatrix}, \quad (16)$$

where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^T \mathbf{s}_1}$, $[\cdot]^T$ denotes matrix transpose, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. (17)

4. (Currently Amended) The method of claim 1, wherein the step of determining synchronization comprises the steps of:

computing \hat{i} , the time occurrence of the information data bit, from the equation;

$$\left| \text{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0, 1, \dots, NS-1\}} \left| \text{Re}\{y[i - k]\} \right| \quad (30c),$$

where $y[i] = \mathbf{w}[i]^T \mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood tests in the set $Y[i]$ given by

$$Y[i] = \{ \left| \text{Re}\{y[i]\} \right|, \dots, \left| \text{Re}\{y[i - NS + 1]\} \right| \},$$

where N is number of chips in the spreading code and S is number of samples per chip time, and $\mathbf{W}[i]^T$ is a tap-weights' vector.

5. (Currently Amended) The method of claim 1, wherein the step of updating weight coefficients comprises the steps of:

computing maximum likelihood estimator for covariance matrix $\hat{\mathbf{R}}_x[i]$

$$\hat{\mathbf{R}}_x[i] = \frac{1}{L} \sum_{m=1}^L \mathbf{x}^{(m)}[i] \mathbf{x}^{(m)*}[i] = \frac{1}{L} \mathbf{X}_0[i] \mathbf{X}_0^T[i].$$

wherein, $\mathbf{x}^{(m)}[i]$ is an observation vector at a sampling time iT_s of the m th symbol, L is approximate number of independent samples of the observation vector $\mathbf{x}^{(m)}[i]$ for the initial acquisition of detector parameters, and the data is given in matrix form by

$$\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]];$$

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computing estimate of $\mathbf{R}_{x_1}[i]$

$$\hat{\mathbf{R}}_{x_1}[i] = \mathbf{B}_1 \hat{\mathbf{R}}_{x_1}[i] \mathbf{B}_1^T = \frac{1}{L} \mathbf{B}_1 \mathbf{X}_0[i] \mathbf{X}_0^T[i] \mathbf{B}_1^T$$

and estimate of cross-correlation vector $\mathbf{r}_{x_1 d_1}$ as,

$$\hat{\mathbf{r}}_{x_1 d_1} = \mathbf{B}_1 \hat{\mathbf{R}}_{x_1}[i] \mathbf{s}_1 = \frac{1}{L} \mathbf{B}_1 \mathbf{X}_0[i] \mathbf{X}_0^T[i] \mathbf{s}_1$$

i

$$\text{computing } \mathbf{w}_{\text{GSC}}^T[i] = \mathbf{r}_{x_1 d_1}^T[i] \mathbf{R}_{x_1}^{-1}[i] \quad (29);$$

$$\text{estimating } \hat{b}_1 = \text{sgn}((\mathbf{u}_1^T - \mathbf{w}_{\text{GSC}}^T[i] \mathbf{B}_1) \mathbf{x}[i]) \quad (35). \quad \text{wherein}$$

$$\mathbf{u}_1^T - \mathbf{w}_{\text{GSC}}^T[i] \mathbf{B}_1 \quad (30a) \quad \text{is a weight vector; and}$$

$$\text{computing output } y[i] = (\mathbf{u}_1^T - \mathbf{w}_{\text{GSC}}^T[i] \mathbf{B}_1) \mathbf{x}[i]. \quad (30b).$$

6. (Currently Amended) The method of claim 1, wherein the step of updating weight coefficients further comprises the steps of:

applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]]$, wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and \mathbf{s}_1 is a designated sender's spreading code;

$$\text{applying } \hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|};$$

applying $\hat{\mathbf{B}}_1 = \mathbf{I} - \hat{\mathbf{u}}_1 \hat{\mathbf{u}}_1^T$, where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^T \mathbf{s}_1}$, $[\cdot]^T$ denotes matrix transpose, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. (17);

for $j = 1$ to $(M - 1)$, computing d_j and \mathbf{x}_j

$$\mathbf{d}_j^T[i] \triangleq [\hat{d}_j^{(1)}[i], \dots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^T[i] \mathbf{X}_{j-1}[i],$$

$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \dots, \mathbf{x}_j^{(L)}[i]] = \hat{\mathbf{B}}_j[i] \mathbf{X}_{j-1}[i]$, where $d_1[i] \triangleq \mathbf{u}_1^T \mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i]$, is an $(N - 1)$ -dimensional process with the signal removed;

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computing $(j+1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x},d_j}[i] = \frac{1}{L} \sum_{m=1}^L \mathbf{x}_j^{(m)}[i] d_j^{(m)*}[i] = \frac{1}{L} \mathbf{X}_j[i] \mathbf{d}_j[i], \text{ where } \hat{\mathbf{r}}_{\mathbf{x},d_j}[i] \text{ is estimate of}$$

cross-correlation vector $\mathbf{r}_{\mathbf{x}|\mathbf{d}_j}$,

$$\hat{\sigma}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x},d_j}[i]\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x},d_j}[i]}{\hat{\sigma}_{j+1}[i]}, \text{ where } \hat{\sigma}_{j+1}[i] = \frac{\|\hat{\mathbf{r}}_{\mathbf{x},d_j}[i]\|}{\hat{\sigma}_{j+1}[i]};$$

computing $(j+1)$ th blocking matrix $\hat{\mathbf{B}}_{j+1}$

$$\hat{\mathbf{B}}_{j+1}[i] = \mathbf{I} - \hat{\mathbf{u}}_{j+1}[i] \hat{\mathbf{u}}_{j+1}^\dagger[i];$$

computing $d_M^{(m)}[i]$ and setting it equal to Mth error signal $\in_M^{(m)}[i]$

$$\mathbf{d}_M^\dagger[i] \triangleq [\hat{d}_M^{(1)}[i], \dots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^\dagger[i] = \hat{\mathbf{u}}_M^\dagger[i] \mathbf{X}_{M-1}[i];$$

applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_M^{(m)}[i]|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i] \hat{\sigma}_M[i]$;

for $j = (M-1)$ to 2, estimating variance of $d_j[i]$

$$\hat{\sigma}_{d_j}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_j^{(m)}[i]|^2;$$

estimating variance of error signal \in_j

$$\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i] \hat{\sigma}_{j+1}^2[i]; \text{ and}$$

computing j th scalar Wiener filter $\hat{\omega}_j[i]$

$$\hat{\omega}_j[i] = \frac{\hat{\sigma}_j[i]}{\hat{\xi}_j[i]}.$$

7. (Currently Amended) The method of claim 1, wherein the step of updating weight coefficients further comprises the steps of:

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applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]]$, wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and \mathbf{s}_1 is a designated sender's spreading code;

applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$ and $\mathbf{x}_0[i] = \mathbf{x}[i]$, where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^T \mathbf{s}_1}$, $[\cdot]^T$ denotes matrix transpose, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. (17);

for $j = 1$ to $(M - 1)$, computing d_j and \mathbf{x}_j

$$d_j[i] = \hat{\mathbf{u}}_j^T[i] \mathbf{x}_{j-1}[i]$$

$$\mathbf{x}_j[i] = \mathbf{x}_{j-1}[i] - \hat{\mathbf{u}}_j[i] d_j[i]$$

$$\mathbf{d}_j^T[i] \triangleq [\hat{d}_j^{(1)}[i], \dots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^T[i] \mathbf{X}_{j-1}[i],$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \dots, \mathbf{x}_j^{(L)}[i]] = \mathbf{X}_{j-1}[i] - \hat{\mathbf{u}}_j[i] \mathbf{d}_j^T[i], \text{ where } d_1[i] \triangleq \mathbf{u}_1^T \mathbf{x}[i]$$

is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i]$, is an $(N - 1)$ - dimensional process with the signal removed;

computing $(j + 1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L} \sum_{m=1}^L \mathbf{x}_j^{(m)}[i] d_j^{(m)*}[i] = \frac{1}{L} \mathbf{X}_j[i] \mathbf{d}_j[i], \text{ where } \hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] \text{ is estimate of}$$

cross-correlation vector $\mathbf{r}_{\mathbf{x} d}$,

$$\hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}, \text{ where } \hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|;$$

computing $d_M^{(m)}[i]$ and setting it equal to M th error signal $\epsilon_M^{(m)}[i]$

$$\mathbf{d}_M^T[i] \triangleq [\hat{d}_M^{(1)}[i], \dots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^T[i] = \hat{\mathbf{u}}_M^T[i] \mathbf{X}_{M-1}[i];$$

$$\text{applying } \hat{\sigma}_{d_M}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_M^{(m)}[i]|^2 = \hat{\xi}_M[i], \quad \hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i] \hat{\delta}_M[i];$$

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for $j = (M-1)$ to 2, estimating variance of $d_j[i]$, $\hat{\sigma}_{d_j}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_j^{(m)}[i]|^2$;

estimating variance of error signal ϵ_j , $\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\epsilon_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i] \hat{\delta}_{j+1}^2[i]$;

and

computing j th scalar Wiener filter by $\hat{w}_j[i]$, $\hat{w}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}$.

8. (Currently Amended) The method of claim 1, wherein the steps of updating weight coefficients and using the updated weight coefficients further comprises the steps of:

for $k = 1$ to n , applying

$$\hat{\mathbf{r}}_{\mathbf{x}_0 d_0}^{(k)}[i] = \mathbf{s}_1, \quad \hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}, \text{ and } \hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|, \text{ wherein } \mathbf{x}_0^{(k)}[i] \text{ is the}$$

received asynchronous data vector, \mathbf{s}_1 is a designated sender's spreading code, and k is k th clock time, where $k=1$ is the first time the data is observed ;

for $j=1$ to $(M-1)$, applying

$$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^\dagger \mathbf{x}_{j-1}^{(k)}[i], \text{ and}$$

$$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i] d_j^{(k)}[i], \text{ where } d_1[i] \triangleq \mathbf{u}_1^\dagger \mathbf{x}[i] \text{ is a signal-plus-}$$

noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i]$, is an $(N-1)$ - dimensional process with the signal removed;

computing $(j+1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}^{(k)}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] = (1 - \alpha) \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i] d_j^{(k)}[i]^* \text{ , where } \hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] \text{ is estimate of}$$

cross-correlation vector $\mathbf{r}_{\mathbf{x} d}$,

$$\hat{\delta}_{j+1}^{(k)}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\|,$$

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$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]}, \text{ wherein } \hat{\delta}_{j+1}^{(k)}[i] = \frac{\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\|}{\alpha} \text{ and } \alpha \text{ is a time}$$

constant;

applying Mth error signal $\epsilon_M^{(k)}[i] = d_M^{(k)}[i]^t = \hat{\mathbf{u}}_M^{(k)}[i]^t \mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, estimating variance of error signal $\epsilon_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\epsilon_j}^{(k)})^2[i] = (1 - \alpha) \hat{\xi}_j^{(k-1)}[i] + |\epsilon_j^{(k)}[i]|^2 ;$$

computing j th scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]} ; \text{ and}$$

computing $(j-1)$ th error signal $\epsilon_{j-1}^{(k)}[i]$

$$\epsilon_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \epsilon_j^{(k)}[i] ; \text{ wherein output at time } k \text{th is}$$

$$y^{(k)}[i] = \epsilon_1^{(k)}[i].$$

9. (Original) An adaptive near-far resistant receiver for an asynchronous wireless system comprising:

means for receiving an asynchronous data vector including a spreading code;

using the received asynchronous data vector, means for updating weight coefficients of an adaptive filter without prior knowledge of synchronization of the spreading code of the data vector;

using the updated weight coefficients, means for determining synchronization of the spreading code; and

means for demodulating the output of the filter using the determined synchronization of the spreading code for obtaining a filtered data vector.

10. (Currently Amended) The receiver of claim 9, further comprising means for dividing the received asynchronous data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation \mathbf{T}_1 on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1 , and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

11. (Currently Amended) The receiver of claim 10, wherein the transformation \mathbf{T}_1 is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^\dagger \\ \mathbf{B}_1 \end{bmatrix}, \quad (16)$$

where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^\dagger \mathbf{s}_1}$, $[\cdot]^\text{T}$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17)

12. (Currently Amended) The receiver of claim 9, wherein the means for determining the synchronization of the spreading code comprises:

means for computing \hat{i} , the time occurrence of the information data bit, from the equation;

$$\left| \text{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0, 1, \dots, NS-1\}} \left| \text{Re}\{y[i - k]\} \right| \quad (30c),$$

where $y[i] = \mathbf{w}[i]^\dagger \mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood ratio tests in the set $Y[i]$ given by $Y[i] = \{ \left| \text{Re}\{y[i]\} \right|, \dots, \left| \text{Re}\{y[i - NS + 1]\} \right| \}$, where N is number of chips in the spreading code and S is number of samples per chip time, and $\mathbf{W}[i]^\dagger$ is a tap-weights' vector.

13. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]]$, wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and \mathbf{s}_1 is a designated sender's spreading code;

means for applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$;

means for applying $\hat{\mathbf{B}}_1 = \mathbf{I} - \hat{\mathbf{u}}_1 \hat{\mathbf{u}}_1^T$, where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^T \mathbf{s}_1}$, $[\cdot]^T$ denotes matrix transpose, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. (17);

for $j = 1$ to $(M - 1)$, means for computing d_j and \mathbf{x}_j

$$\mathbf{d}_j^T[i] \triangleq [\hat{d}_j^{(1)}[i], \dots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^T[i] \mathbf{X}_{j-1}[i],$$

$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \dots, \mathbf{x}_j^{(L)}[i]] = \hat{\mathbf{B}}_j[i] \mathbf{X}_{j-1}[i]$, where $d_1[i] = \mathbf{u}_1^T \mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i]$, is an $(N - 1)$ - dimensional process with the signal removed;

means for computing $(j+1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L} \sum_{m=1}^L \mathbf{x}_j^{(m)}[i] d_j^{(m)}[i]^* = \frac{1}{L} \mathbf{X}_j[i] \mathbf{d}_j[i], \text{ where } \hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] \text{ is estimate of}$$

cross-correlation vector $\mathbf{r}_{\mathbf{x} d_j}$,

$$\hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}, \text{ where } \hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|;$$

means for computing $(j+1)$ th blocking matrix $\hat{\mathbf{B}}_{j+1}$

$$\hat{\mathbf{B}}_{j+1}[i] = \mathbf{I} - \hat{\mathbf{u}}_{j+1}[i] \hat{\mathbf{u}}_{j+1}^T[i];$$

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means for computing $d_M^{(m)}[i]$ and set it equal to Mth error signal $\epsilon_M^{(m)}[i]$

$$\mathbf{d}_M^t[i] \triangleq [\hat{d}_M^{(1)}[i], \dots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^t[i] = \hat{\mathbf{u}}_M^t[i] \mathbf{X}_{M-1}[i];$$

means for applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_M^{(m)}[i]|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i] \hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, means for estimating variance of $d_j[i]$

$$\hat{\sigma}_{d_j}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_j^{(m)}[i]|^2;$$

means for estimate variance of error signal ϵ_j

$$\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\epsilon_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i] \hat{\delta}_{j+1}^2[i]; \text{ and}$$

means for computing j th scalar Wiener filter $\hat{\omega}_j[i]$

$$\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}.$$

14. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]]$, wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and \mathbf{s}_1 is a designated sender's spreading code;

means for applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$ and $\mathbf{x}_0[i] = \mathbf{x}[i]$ where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^T \mathbf{s}_1}$, $[\cdot]^T$ denotes matrix transpose, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. (17);

for $j = 1$ to $(M-1)$, means for computing d_j and \mathbf{x}_j

$$d_j[i] = \hat{\mathbf{u}}_j^t[i] \mathbf{x}_{j-1}[i]$$

$$\mathbf{x}_j[i] = \mathbf{x}_{j-1}[i] - \hat{\mathbf{u}}_j[i] d_j[i]$$

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$$\mathbf{d}_j^{\dagger}[i] \triangleq [\hat{d}_j^{(1)}[i], \dots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{\dagger}[i] \mathbf{X}_{j-1}[i],$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \dots, \mathbf{x}_j^{(L)}[i]] = \mathbf{X}_{j-1}[i] - \hat{\mathbf{u}}_j[i] \mathbf{d}_j^{\dagger}[i], \text{ where } \underline{d_1[i] \triangleq \mathbf{u}_1^{\dagger} \mathbf{x}[i]}$$

is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i]$, is an $(N-1)$ -dimensional process with the signal removed;

means for computing $(j+1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L} \sum_{m=1}^L \mathbf{x}_j^{(m)}[i] d_j^{(m)*}[i] = \frac{1}{L} \mathbf{X}_j[i] \mathbf{d}_j[i], \text{ where } \underline{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] \text{ is estimate of}}$$

cross-correlation vector $\mathbf{r}_{\mathbf{x} d}$;

$$\hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}, \text{ where } \underline{\hat{\delta}_{j+1}[i] \triangleq \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|};$$

means for computing $d_M^{(m)}[i]$ and set it equal to Mth error signal $\in_M^{(m)}[i]$

$$\mathbf{d}_M^{\dagger}[i] \triangleq [\hat{d}_M^{(1)}[i], \dots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^{\dagger}[i] = \hat{\mathbf{u}}_M^{\dagger}[i] \mathbf{X}_{M-1}[i];$$

means for applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_M^{(m)}[i]|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i] \hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, means for estimating variance of $d_j[i]$, $\hat{\sigma}_{d_j}^2[i] = \frac{1}{L} \sum_{m=1}^L |\hat{d}_j^{(m)}[i]|^2$

;

means for estimating variance of error signal \in_j , $\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] -$

$\hat{\xi}_{j+1}^{-1}[i] \hat{\delta}_{j+1}^2[i]$; and

means for computing j th scalar Wiener filter by $\hat{\omega}_j[i]$, $\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}$.

15. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data and updates weight coefficients further comprises:

for $k = 1$ to n , means for applying

$$\hat{\mathbf{r}}_{\mathbf{x}_0 d_0}^{(k)}[i] = \mathbf{s}_1, \quad \hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}, \quad \text{and} \quad \hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|, \quad \text{wherein } \mathbf{x}_0^{(k)}[i] \text{ is the}$$

received asynchronous data vector, \mathbf{s}_1 is a designated sender's spreading code, and k is k th clock time, where $k=1$ is the first time the data is observed ;

for $j=1$ to $(M-1)$, means for applying

$$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^\dagger \mathbf{x}_{j-1}^{(k)}[i], \quad \text{and}$$

$$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i] d_j^{(k)}[i], \quad \text{where } d_1[i] \equiv \mathbf{u}_1^\dagger \mathbf{x}[i] \text{ is a signal-plus-}$$

noise scalar process and } \mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i], \text{ is an } (N-1) \text{ - dimensional process with the signal removed;}

means for computing $(j+1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}^{(k)}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] = (1 - \alpha) \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i] d_j^{(k)}[i]^*, \quad \text{where } \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \text{ is estimate of}$$

cross-correlation vector } \mathbf{r}_{\mathbf{x} d}

$$\hat{\delta}_{j+1}^{(k)}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\|,$$

$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]}, \quad \text{wherein } \hat{\delta}_{j+1}^{(k)}[i] \equiv \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\| \text{ and } \alpha \text{ is a time}$$

constant;

means for applying $\epsilon_M^{(k)}[i] = d_M^{(k)}[i]^\dagger = \hat{\mathbf{u}}_M^{(k)}[i]^\dagger \mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, means for estimating variance of error signal } \epsilon_j^{(k)}[i]

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\epsilon_j}^{(k)})^2[i] = (1 - \alpha) \hat{\xi}_j^{(k-1)}[i] + |\epsilon_j^{(k)}[i]|^2 ;$$

means for computing j th scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

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$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\xi_j^{(k)}[i]} ; \text{ and}$$

means for computing $(j-1)$ th error signal $\epsilon_{j-1}^{(k)}[i]$

$$\epsilon_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \epsilon_j^{(k)}[i] ; \text{ wherein output at time } k\text{th is } y^{(k)}[i] = \epsilon_1^{(k)}[i].$$

16. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for computing maximum likelihood estimator for covariance matrix $\mathbf{R}_x[i]$

$$\hat{\mathbf{R}}_x[i] = \frac{1}{L} \sum_{m=1}^L \mathbf{x}^{(m)}[i] \mathbf{x}^{(m)*}[i] = \frac{1}{L} \mathbf{X}_0[i] \mathbf{X}_0^H[i].$$

wherein, $\mathbf{x}^{(m)}[i]$ is an observation vector at a sampling time iT_s of the m th symbol, L is the number of independent samples of the observation vector $\mathbf{x}^{(m)}[i]$ for the initial acquisition of detector parameters, and the data is given in matrix form by

$$\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \dots, \mathbf{x}^{(L)}[i]] ;$$

means for computing estimate of $\mathbf{R}_{x_1}[i]$

$$\hat{\mathbf{R}}_{x_1}[i] = \mathbf{B}_1 \hat{\mathbf{R}}_x[i] \mathbf{B}_1^H = \frac{1}{L} \mathbf{B}_1 \mathbf{X}_0[i] \mathbf{X}_0^H[i] \mathbf{B}_1^H$$

and estimate of cross-correlation vector $\mathbf{r}_{x_1 d_1}$ as,

$$\hat{\mathbf{r}}_{x_1 d_1} = \mathbf{B}_1 \hat{\mathbf{R}}_x[i] \mathbf{s}_1 = \frac{1}{L} \mathbf{B}_1 \mathbf{X}_0[i] \mathbf{X}_0^H[i] \mathbf{s}_1$$

means for computing $\mathbf{w}_{\text{GSC}}^H[i] = \mathbf{r}_{x_1 d_1}^H[i] \mathbf{R}_{x_1}^{-1}[i]$ (29);

means for estimating $\hat{b}_1 = \text{sgn}((\mathbf{u}_1^H - \mathbf{w}_{\text{GSC}}^H[i] \mathbf{B}_1) \mathbf{x}[i])$ (35) , wherein

$\mathbf{u}_1^H - \mathbf{w}_{\text{GSC}}^H[i] \mathbf{B}_1$ (30a) is a weight vector; and

means for computing output $y[i] = (\mathbf{u}_1^H - \mathbf{w}_{\text{GSC}}^H[i] \mathbf{B}_1) \mathbf{x}[i]$. (30b).

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17. (Original) A digital signal processor having stored thereon a set of instructions including instructions for filtering interference and noise of an asynchronous wireless signal, when executed, the instructions cause the digital signal processor to perform the steps of:

- receiving an asynchronous data vector including a spreading code;
- using the received asynchronous data vector, updating weight coefficients of an adaptive filter without prior knowledge of synchronization of the spreading code of the data vector;
- using the updated weight coefficients information data bits to determine the synchronization of the spreading code of the data vector; and
- demodulating the output of the filter using the determined synchronization of the spreading code of the data vector for obtaining a filtered data vector.

18. (Currently Amended) The digital signal processor of claim 17, further comprising instructions for dividing the received asynchronous data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation \mathbf{T}_1 on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1 , and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

19. (Currently Amended) The digital signal processor of claim 18, wherein the transformation \mathbf{T}_1 is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^\dagger \\ \mathbf{B}_1 \end{bmatrix}, \quad (16)$$

where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^\dagger \mathbf{s}_1}$, $[\cdot]^\dagger$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$.

(17)

20. (Currently Amended) The digital signal processor of claim 17, wherein the instructions for determining synchronization comprises instructions for:

computing \hat{i} , the time occurrence of the information data bit, from the equation;

$$\left| \operatorname{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0, 1, \dots, NS-1\}} \left| \operatorname{Re}\{y[i - k]\} \right| \quad (30c),$$

where $y[i] = \mathbf{w}[i]^T \mathbf{x}[i]$ is filtered output from a likelihood test at clock time i detecting sequentially maximum of all likelihood tests in the set $Y[i]$ given by

$Y[i] = \{ \left| \operatorname{Re}\{y[i]\} \right|, \dots, \left| \operatorname{Re}\{y[i - NS + 1]\} \right| \}$, where N is number of chips in the spreading code and S is number of samples per chip time, and $\mathbf{W}[i]^T$ is a tap-weights' vector.

21. (Original) An adaptive receiver for filtering interference and noise of an asynchronous wireless signal comprising:

means for receiving an asynchronous data vector including information data bits;

means for updating weight coefficients of an adaptive filter without a prior knowledge of synchronization of the information data bits;

using the updated weight coefficient, means for determining the start of the information data bits; and

means for demodulating the output of the adaptive filter.

22. (Original) The adaptive receiver of claim 21, further comprising means for dividing the data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation \mathbf{T}_1 on $\mathbf{x}[i]$, represented by $\mathbf{T}_1 \mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1 , and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

23. (Currently Amended) The adaptive receiver of claim 22, wherein the transformation \mathbf{T}_1 is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^\dagger \\ \mathbf{B}_1 \end{bmatrix}, \quad (16)$$

where \mathbf{B}_1 is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1 / \sqrt{\mathbf{s}_1^\dagger \mathbf{s}_1}$, $[\cdot]^\dagger$ denotes matrix transpose, and where $\mathbf{B}_1 \mathbf{u}_1 = \mathbf{B}_1 \mathbf{s}_1 = 0$. (17)

24. (Currently Amended) The adaptive receiver of claim 21, wherein the means for determining the start of the information data bits comprises means for:

computing \hat{i} , the time occurrence of the information data bit, from the equation;

$$\left| \text{Re}\{y[\hat{i}]\} \right| = \max_{k \in \{0, 1, \dots, NS-1\}} \left| \text{Re}\{y[i-k]\} \right| \quad (30c),$$

where $y[i] = \mathbf{w}[i]^\dagger \mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood ratio tests in the set $Y[i]$ given by

$Y[i] = \{ \left| \text{Re}\{y[i]\} \right|, \dots, \left| \text{Re}\{y[i-NS+1]\} \right| \}$, where N is number of chips in the spreading code and S is number of samples per chip time, and $\mathbf{W}[i]^\dagger$ is a tap-weights' vector.

25. (Currently Amended) The adaptive receiver of claim 21, wherein the means for determining the start of the information data bits comprises:

for $k = 1$ to n , means for applying

$$\hat{\mathbf{r}}_{\mathbf{x}_0 d_0}^{(k)}[i] = \mathbf{s}_1, \quad \hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}, \quad \text{and} \quad \hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|, \quad \text{wherein } \mathbf{x}_0^{(k)}[i] \text{ is the}$$

received asynchronous data vector, \mathbf{s}_1 is a designated sender's spreading

code, and k is k th clock time, where $k=1$ is the first time the data is observed ;

for $j=1$ to $(M-1)$, means for applying

$$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^\dagger \mathbf{x}_{j-1}^{(k)}[i], \text{ and}$$

$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i] d_j^{(k)}[i]$, where $d_1[i] = \mathbf{u}_1^\dagger \mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1 \mathbf{x}[i]$, is an $(N-1)$ – dimensional process with the signal removed;

means for computing $(j+1)$ th stage basis vector $\hat{\mathbf{u}}_{j+1}^{(k)}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] = (1 - \alpha) \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i] d_j^{(k)}[i]^* \text{ , where } \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \text{ is estimate of}$$

cross-correlation vector $\mathbf{r}_{\mathbf{x} d L}$,

$$\hat{\sigma}_{j+1}^{(k)}[i] = \left\| \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \right\|,$$

$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\sigma}_{j+1}^{(k)}[i]}, \text{ wherein } \hat{\sigma}_{j+1}^{(k)}[i] = \left\| \hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] \right\| \text{ and } \alpha \text{ is a time}$$

constant;

means for applying Mth error signal $\epsilon_M^{(k)}[i] = d_M^{(k)}[i]^\dagger = \hat{\mathbf{u}}_M^{(k)}[i]^\dagger \mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, means for estimating variance of error signal $\epsilon_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\sigma}_{\epsilon_j}^{(k)})^2 [i] = (1 - \alpha) \hat{\xi}_j^{(k-1)}[i] + \left| \epsilon_j^{(k)}[i] \right|^2 ;$$

means for computing j th scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\sigma}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]} ; \text{ and}$$

means for computing $(j-1)$ th error signal $\epsilon_{j-1}^{(k)}[i]$

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$$\epsilon_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{w}_j^{(k)}[i]^* \epsilon_j^{(k)}[i] ; \text{ wherein output at time } k\text{th is } y^{(k)}[i] = \epsilon_1^{(k)}[i].$$